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Global Space-based Inter-Calibration System

Newsletter– Winter 2016 Issue

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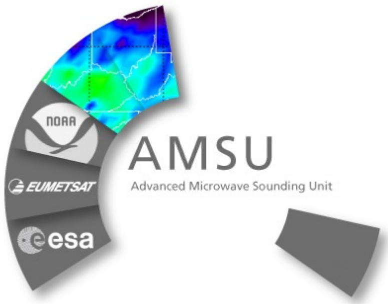
In This Issue



Sentinel-3A placed in orbit

Jason-3 launched

Channel frequency shifts, drifts and uncertainities in microwave sounding observations

By William Bell, Met Office, UK

Observations from microwave sounding instruments have been exploited widely for numerical weather prediction (NWP) and for climate studies assessing long-term trends in atmospheric temperatures. Observations from channels in the 50-58 GHz range have been particularly valuable in providing information on tropospheric and stratospheric temperatures and are currently one of the most beneficial observation types in current global NWP systems.

The homogenisation and reprocessing of this data in support of climate trend analyses and atmospheric reanalyses continue to be active areas of research. As these applications mature, and the data quality tolerances become ever more stringent, new studies are uncovering a range of mechanisms that contribute to the biases observed in the data. For example, several studies have provided evidence of shifts, drifts and uncertainties in the channel center frequencies for several microwave radiometers - and these are the subject of this article. The radiometers of concern here are total power heterodyne radiometers, which generally employ local oscillators (LOs) in the form of Gunn diode oscillators or dielectric relaxation oscillators.

For key tropospheric channels bandwidths are in the range 330 - 400 MHz. For stratospheric sounding channels, the bandwidth decreases as the altitude of the channel peak sensitivity increases – from 33MHz in the lower stratosphere to 3 MHz in the upper stratosphere. The specified stability of the Advanced Microwave Sounding Unit-A (AMSU-A) channels is in the range ± 5-10 MHz for the mid-upper tropospheric sounding channels (6-8) and ± 0.5-1.2 MHz for the stratospheric channels (9-14). These nominal stabilities are achieved through passive stabilisation for the (broad) tropospheric channels and through active locking, by means of a phase-locked loop (PLL), for the (narrow) stratospheric channels (9-14), although until recently no study had confirmed that these stabilities are achieved on-orbit.

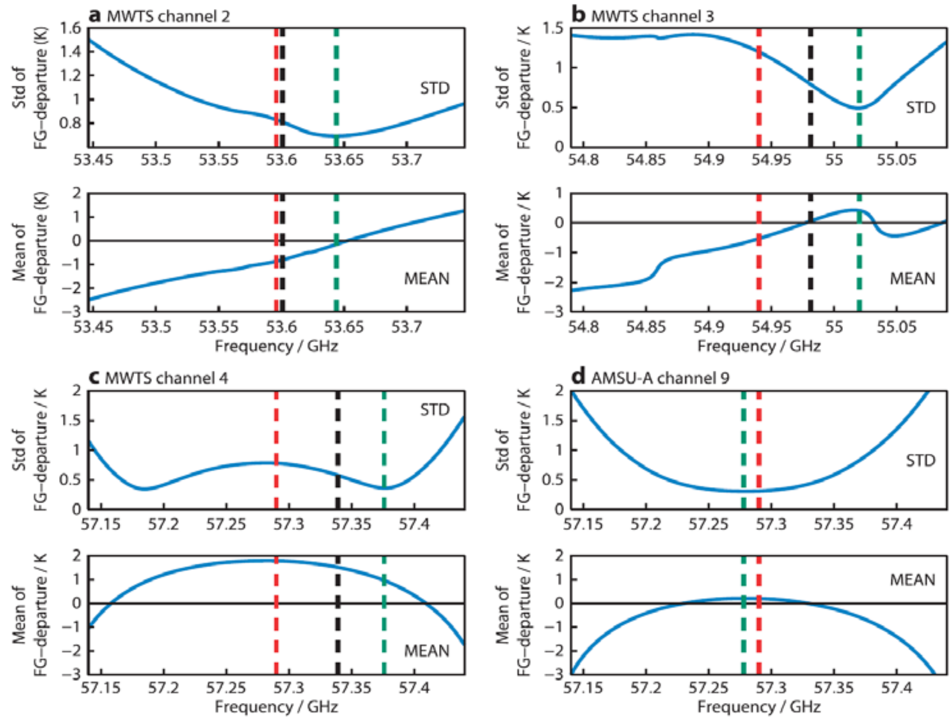


Figure. 1: The variation of (top) standard deviation and (bottom) mean of departures (observation minus model equivalent brightness temperatures) with channel shift for MWTS channels (a) 2, (b) 3, and (c) 4 and (d) AMSU-A channel 9. The design-specified channel center frequency (dashed red line), based on prelaunch measurements (black dashed line), and frequency corresponding to the minimum in the first-guess departures (green dotted line) are shown (reproduced from Lu et al, 2011)

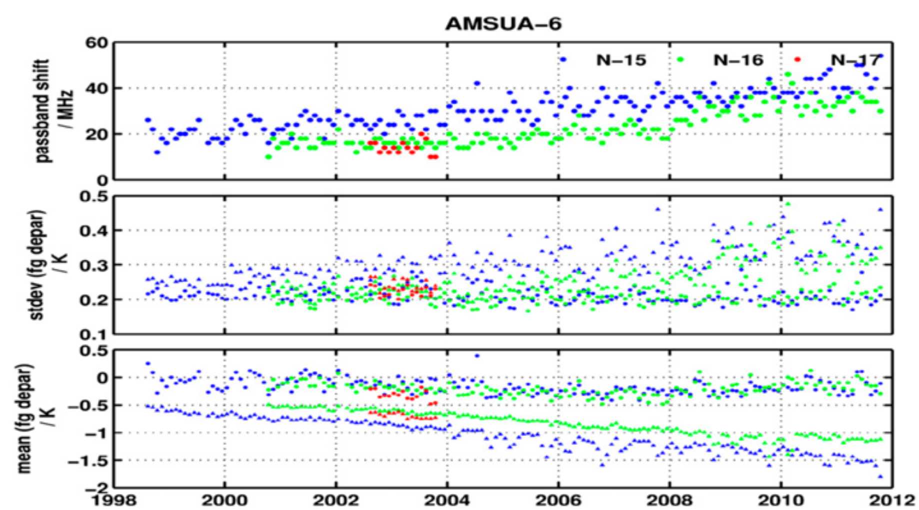


Figure 2: The evolution of channel centre frequency shift estimates and associated departure statistics for AMSU-A channel 6 (nominally centred at 54.40 GHz) covering the period 1998–2012. Estimates were obtained from a single assimilation cycle each month during the period, on the 15th of each month. Shown are (top) the derived frequency drift, (middle) the standard deviation of the first-guess departures for un-shifted (triangles) and shifted (circles) pass bands, and (bottom) the mean first-guess departure for un-shifted (triangles) and shifted (circles) pass bands. Results are shown for NOAA-15, NOAA-16, and NOAA-17 (reproduced from Lu and Bell, 2014).

NWP-based assessments of sounding data, in which NWP fields are mapped to brightness temperatures using a radiative transfer model and compared to observations, have proved to be particularly effective in assessing temperature sounding observations. The value of this type of analysis stems from the high accuracy of NWP models fields in representing global atmospheric temperatures, at least at the horizontal and vertical scales observed by current sounders, as well as the complete geographical sampling provided by global models.
The first application of these techniques to study shifts in channel centre frequencies was reported by Lu *et al* in 2011. In this study, data from the microwave temperature sounder (MWTS) on China's polar orbiting satellite FY-3A was compared to simulated observations based on short range forecasts from the European Centre for Medium Range Weather Forecasting (ECMWF). The approach involved iteratively adjusting the assumed centre frequency and inspecting the variation of observation / model differences for a large ensemble of observations (also known as first guess departures, or innovations). Figure 1 shows the variation of first guess departure statistics (mean and standard deviation) with assumed centre frequency for the MWTS channels. Where a shift in the assumed centre frequency results in a very significant improvement in observation/model fit the assumed shift is assumed to be real and significant.
In three of the MWTS channels (2, 3 and 4), shifts of 33-55 MHz relative to pre-launch measurements were diagnosed. These shifts were later attributed to changes in the refractive index of the LO's micro-cavity medium from on-ground (ambient pressure) to on-orbit conditions (vacuum). This mechanism is expected to result in calculable shifts of

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32-33 MHz, in reasonable agreement with the NWP-based analysis. By using the NWP-diagnosed channel centre frequencies, Lu et al. were able to significantly improve the MWTS data quality.

The same techniques were subsequently applied to MSU and AMSU-A observations covering the period 1979-2012 by Lu and Bell (2014). It has been known for many years that key channels of MSU and AMSU-A exhibit complex inter-satellite and, in some cases, time dependent biases. Lu and Bell showed that AMSU-A channels 6-8 on many satellites exhibit evidence of shifts relative to nominal channel center frequencies, of tens of MHz in some cases. The analysis found that for some channels on some satellites (NOAA-15 and -16) the channel centre frequencies appeared to drift in time following launch (see Figure 2). The study also concluded that for the stratospheric channels of AMSU-A (channels 9-14) there was no evidence of significant shifts, which is consistent with the active locking applied to these channels. The conclusions were also insensitive to the choice of NWP model – similar results were found using ECMWF, NCEP, Met Office and CMA global models. Assuming revised pass band centres frequencies in the calculation of simulated observations resulted in improved observation-model fit, reduced biases (observation versus NWP) and inter-satellite biases, and reduced seasonality in the observation-model misfit.

Shifts for MSU channel 3 were diagnosed for operational instruments from TIROS-N in 1979 to NOAA-14 in 2007. Large shifts were diagnosed, especially for earlier satellites. For example for TIROS-N the shift is estimated to be 68 MHz. In common with the AMSU-A analysis the use of revised channel center frequencies resulted in significant improvements in the observation/model misfit, the mean biases and in the seasonality of the misfit. The study also indicated that, taking the revised passband frequencies into account, the radiometric calibration of the MSU instruments is consistent to 0.5K.

References

Qifeng Lu, William Bell, Peter Bauer, Niels Bormann, Carole Peubey, 2011, Characterizing the FY-3A Microwave Temperature Sounder Using the ECMWF Model, Journal of Atmospheric and Oceanic Technology, Volume 28, Issue 11 (November 2011) pp. 1373-1389, doi: http://dx.doi.org/10.1175/JTECH-D-10-05008.1

Qifeng Lu, William Bell, 2014, Characterizing Channel Center Frequencies in AMSU-A and MSU Microwave Sounding Instruments, Journal of Atmospheric and Oceanic Technology, Volume 31, Issue 8 (August 2014) pp. 1713-1732, doi: http://dx.doi.org/10.1175/JTECH-D-13-00136.1

Discuss the Article

Reflector Emission Correction for ATMS Calibration

By Hu Yang and Fuzhong Weng, NOAA

Introduction

The ATMS flight reflector is made of Beryllium with a nominally 0.6 micron gold plating layer, on a Nickel interfacing layer. Since the gold plating thickness is comparable to the skin depth, and is likely to have extreme microscopic granularity and roughness, it is not unexpected that the emissivity would greatly exceed the values computed from the theoretical equation. Studies on the pitch maneuver data showed a scan-angle dependent radiometric bias with respect to the cold space background brightness temperature of 2.73 K. In particular, the biases at ATMS channels 1, 2, and 16 are a sine-squared function of scan angle (smile shape) whereas the rest of channels are a cosine-squared function of scan angle (frown shape). In this paper, based on studies from different researchers on legacy NOAA MSU and AMSU instruments, and the analysis for on-orbit pitch over observations from the newest SNPP ATMS instrument, a theoretical model was established to explain the major root cause of scan angle dependent bias observed in NOAA microwave sounding instruments. This model is built based on the assumption that the polarization dependent thermal emission of scan mirror plays a major role for the observed bias.

Verification of ATMS Calibration Accuracy through SNPP Pitch Maneuver Observations

On February 18, 2012, the Suomi NPP satellite was commanded to look over at cold space. For ATMS, this maneuver establishes a baseline radiometer output from pure cold space. The spacecraft is nadir view pitched completely off of the Earth to enable all the instruments to acquire full scans of deep space, permitting the uniformity of the field of view to be characterized. Figure 1 shows ATMS antenna brightness temperatures at channels 1 and 3 from all the data processed by the JPSS ground software called Algorithm Dynamic Library (ADL) version 5.1,1 which applied a full radiance calibration. Note that the data point at each scan position is averaged from all the observations between 1820 UTC to 1845 UTC when ATMS scans through space. The biases at channel 1, 2 and 16 are negative and those at other channels are positive. The magnitudes of biases exceeded those predicted by the PFM error budget model. It is also shown that the bias at each channel depends on scan angle. The patterns for quasi-vertical polarization at channels 1, 2, and 16 are in a “smile” shape whereas

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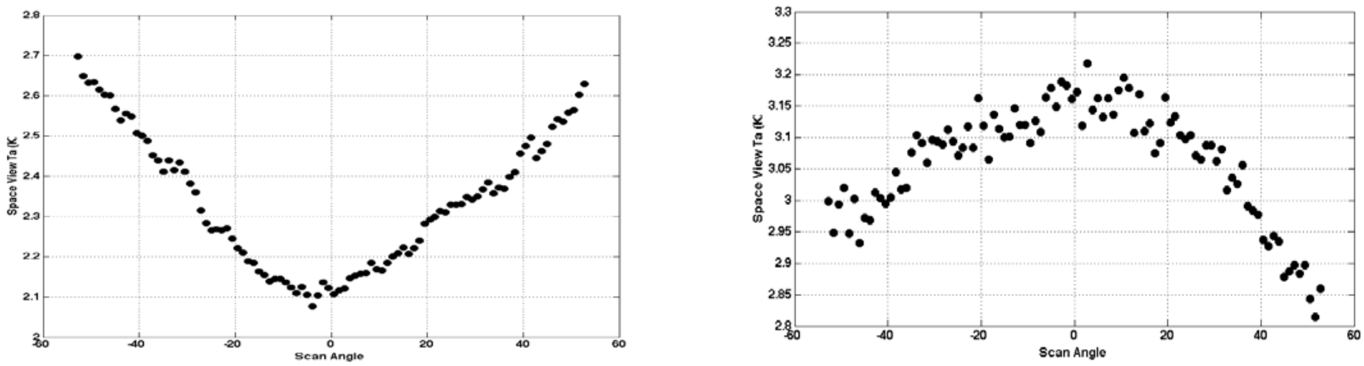

Figure 1: Examples of Suomi NPP ATMS mean brightness temperature vs scan angle for channels 1 (left panel) and 3 (right panel) derived from the pitch maneuver observations

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those for quasi-horizontal polarization are in "frown" shape. The clear bias at the nadir positions and the distinct scan angle dependent bias can be well explained by the antenna emission model which is discussed in details in next session.

A Model for Further Improvement to ATMS Calibration Accuracy

The model attempts to use newly determined reflector emissions that take into consideration extreme microscopic roughness and granularity and then compute radiance values.

Estimates of emissivity for the PFM flight unit, based on the pitch-over maneuver, were in the range of 0.0025 to 0.0065, over all the ATMS frequency bands. For comparison, the Hagen-Rubens equation gives ~0.0005 to 0.0014 for pure bulk gold, over the range of 23 to 183 GHz. From ATMS pitch-over data, Yang and Weng (2016) derived the spectral emissivity is in a range of 0.0026 to 0.0063.

Also, radiances for quasi-V and -H channels are derived as

$$R^c_{qv} = R_{qv} + \varepsilon_h(R_r - R_h) + [\varepsilon_v(R_r - R_v) - \varepsilon_h(R_r - R_h)]\sin^2\theta - \frac{R_3}{2}(1-\varepsilon_h)^{3/2}\sin 2\theta \quad \text{...(2a)}$$

and

$$R^c_{qh} = R_{qh} + \varepsilon_h(R_r - R_h) + [\varepsilon_v(R_r - R_v) - \varepsilon_h(R_r - R_h)]\cos^2\theta + \frac{R_3}{2}(1-\varepsilon_h)^{3/2}\sin 2\theta \quad \text{...(2b)}$$

respectively, where R_{qv} and R_{qh} are the quasi-V and -H radiances from Eq. (1), respectively. R^c_{qv} and R^c_{qh} are the quasi-V and -H radiances contributed from the reflector emitted radiation, respectively. R_v,R_h and R_3 are the radiative components at pure vertical and horizontal polarization, and the third Stokes component. R_r is the radiance emitted from reflector. ε_v and $\varepsilon_h$are the reflector emissivity at the vertical and horizontal polarization. At an incident angle of 45 degree to the reflector normal,

$$\varepsilon_v = 2\varepsilon_h - \varepsilon_h^2 \quad \text{...(3)}$$

From Eq. (2), we can first estimate the effects of the reflector emission on radiation from warm and cold calibration targets. It is clear that the corrections to warm target brightness temperatures are much smaller, compared to those corrections made to the cold calibration. This is because the warm target temperature (300K) is operated close to the antenna reflector temperature (~280K). The uncertainty introduced by the antenna emission to the cosmic radiative temperature (2.728K) is also dependent on frequency or channel.

The implications from the ATMS pitch maneuver data are several fold. First, in the ATMS radiometric calibration, antenna reflector emission must be taken into account the total radiation from two calibration targets. Second, when the ATMS antenna brightness temperatures are compared with theoretical simulations, a full polarimetric forward model including the third Stokes component should be utilized as Eq. (2). If the polarization components in Eq. (2) in the last three terms are neglected, the biases are very pronounced. As shown in Fig. 2, the biases can become asymmetric when ocean wind speed is greater than 15 m/s.

4. Conclusion

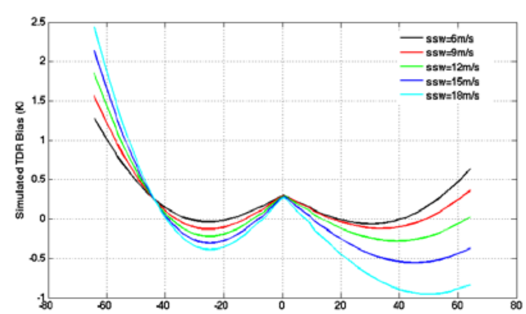

Figure 2 : Biases of ATMS antenna brightness temperature at channel 1 as a function of local zenith angle over oceans. Surface wind speed varies from 5 to 18 m/s. Reflector temperature is assumed as 283 K and its emissivity of 0.0028.

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Using the Mueller matrix of reflection and transmission at 45° angle for a bulk-material reflector, we derived a full vector expression for reflected radiation for non-lossless, polarized rotating reflector. The physical model is then applied to the two-point calibration equation and the ATMS calibration accuracy is improved.

References

Hu Yang and Fuzhong Weng, 2016, "Estimation of ATMS Antenna Emission from Cold Space Observations", IEEE Transactions on Geoscience and Remote Sensing, in print

Discuss the Article

Empirical Correction of Satellite Cloud Records

By Joel Norris and Amato Evan, Scripps Institution of Oceanography

Clouds have a large impact on Earth's radiation budget. They typically reflect more solar radiation back to space than the un-obscured surface and emit less thermal infrared radiation to space than the clear sky atmosphere. Changes in the horizontal extent, optical thickness, height and other properties of clouds in response to global warming will modify reflection of solar radiation and emission of thermal radiation and may exert a feedback on the climate system. How cloud properties will respond to global warming is not fully understood, however, and remains a key uncertainty in our understanding of climate change. One reason for this uncertainty is that conventional cloud records obtained from weather satellites lack long-term stability needed for monitoring climate. New instruments, calibration drifts, orbital changes, and other factors have introduced spurious variability that usually overwhelms any real long-term signal. Although the presence of large systematic artifacts prevents the use of satellite data in studies of long-term cloud trends, the fact that the artifacts are systematic provides the opportunity to characterize and empirically remove them.

We have recently developed a procedure to remove spurious variability from the two most widely used lengthy satellite cloud records: the International Satellite Cloud Climatology Project (ISCCP) and the Pathfinder Atmospheres - Extended (PATMOS-x) dataset (Norris and Evan 2015). Our approach is to apply a first-order Taylor series expansion about the climatological mean to the time series of retrieved cloud amount at each grid box,

$$C(a_1, a_2, \ldots, r_1, r_2, \ldots) \approx C(\bar{a}_1, \bar{a}_2, \ldots, \bar{r}_1, \bar{r}_2, \ldots) + \frac{\partial C}{\partial a_1} a_1' + \frac{\partial C}{\partial a_2} a_2' + \ldots + \frac{\partial C}{\partial r_1} r_1' + \frac{\partial C}{\partial r_2} r_2' + \ldots \quad \text{.....(1)}$$

where C is cloud fraction, a_i are factors producing artificial variability, r_i are meteorological factors producing real variability, the overbar indicates the climatological mean, and the prime indicates departures from the climatological mean. Since we are interested in cloud variability, we do not concern ourselves with time-mean biases and drop the climatological terms from (1),

$$C' \approx \frac{\partial C}{\partial a_1} a_1' + \frac{\partial C}{\partial a_2} a_2' + \ldots + \frac{\partial C}{\partial r_1} r_1' + \frac{\partial C}{\partial r_2} r_2' + . \quad \text{...(2)}$$

Corrected cloud fraction anomalies (C^*), which are the component of C influenced by the factors producing real variability (r_i), can be obtained by subtracting the artifact terms from the reported cloud fraction anomaly C',

$$C^* \approx C' - \frac{\partial C}{\partial a_1} a_1' - \frac{\partial C}{\partial a_2} a_2' - \ldots$$

Classifying some factors as artificial does not entail that no real physical effects are involved but rather that they lead to a systematic bias in retrieved cloud fraction. Note that C, a_i, and r_i vary with time and location.

Since values for $\partial C/\partial a_i$ are not known from first principles, we obtain them empirically for each artifact factor via least squares linear regression. Artifact factor anomalies a_i' are the independent variable, cloud fraction anomalies C' are the dependent variable, and $\partial C/\partial a_i$ is the computed regression coefficient. One type of artifact present in ISCCP is a systematic relationship between changes in reported cloud fraction and changes in geostationary satellite zenith angle. In this case, we represent a_1' by anomalies in the cosine of satellite zenith angle. Another type of artifact primarily affecting PATMOS-x is a systematic relationship between changes in reported cloud fraction and changes in equatorial crossing time. In this case, we represent a_2' by anomalies in the cosine of solar zenith angle.

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A third type of artifact present in both ISCCP and PATMOS-x is related to transitions between satellites and effective changes in calibration that produce spatially coherent changes in cloud fractions at every location viewed by a satellite. In this case, we represent a_3' by the spatial average of standardized grid box anomalies across the entire area viewed by the satellite. Residuals from the best fit line between C' and a_i' become our corrected cloud anomalies from which spurious variability has been removed.

Figure 1 displays linear trends in total cloud amount at each grid box during 1983-2009 for the original and corrected versions of the ISCCP dataset. The spatial pattern of trends in the original data is clearly artificial and displays circular patterns associated with areas viewed by geostationary satellites over Europe, the U.S., and Japan (Figure 1a). These artificial patterns are largely absent from the corrected data (Figure 1b).

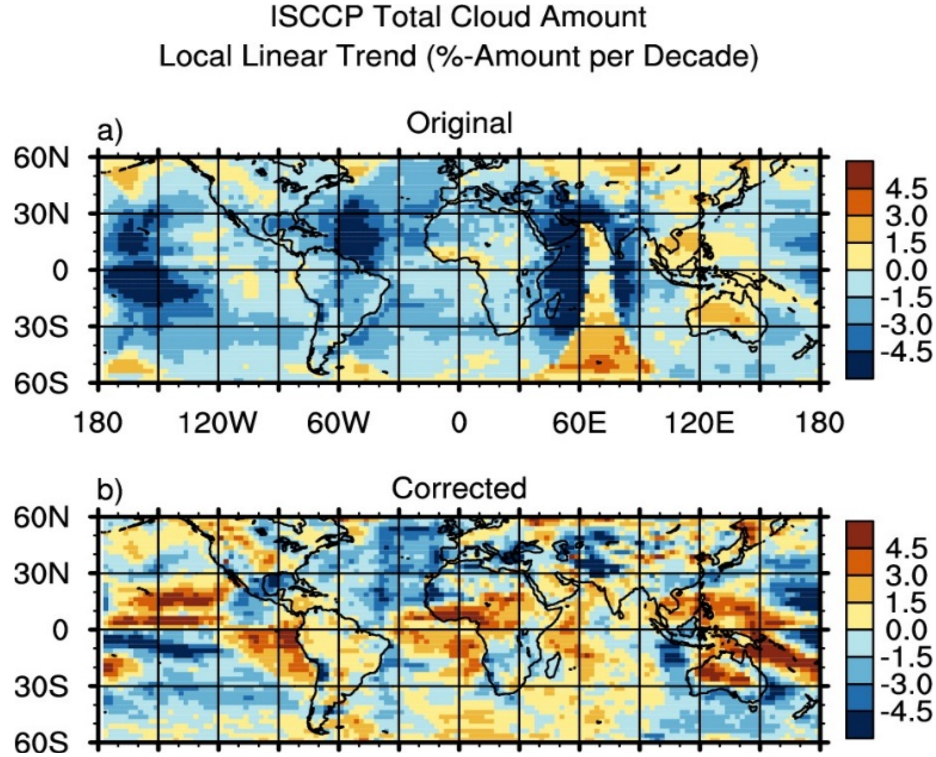

Figure 1: Local linear trend in total cloud amount during 1983-2009 for the original (a) and corrected (b) versions of the ISCCP satellite record.

One critical limitation of our empirically-based correction method is that any real variability that is linearly correlated with an artifact factor is removed along with the spurious variability. In particular, we cannot distinguish globally-coherent changes in retrieved cloudiness due to an artificial cause (e.g., satellite transition, calibration drift, volcanic aerosol loading, etc.) from globally-coherent changes in retrieved cloudiness due to a real cause. Consequently, the corrected datasets cannot be used to study global mean cloud changes. Despite this shortcoming, we consider a corrected dataset with some real variability removed preferable to a dataset with no real variability removed but dominated by artifacts. We find that removing global mean cloud corrected anomalies variability has little impact on regional patterns. The corrected ISCCP and PATMOS-x datasets we have produced will be very useful for studying regional patterns of cloud change arising from natural variability or as a response to global warming.

References

Norris, J. R., and A. T. Evan, 2015, Empirical removal of artifacts from the ISCCP and PATMOS-x satellite cloud records. J. Atmos. Oceanic Technol., Vol.32, 691-702, 10.1175/JTECH-D-14-00058.1

Discuss the Article

Inter-calibration of the GPM Radiometer Constellation

By Wesley Berg, (CSU) and Rachael Kroodsma, NASA

Introduction

The Global Precipitation Measurement (GPM) mission is a constellation-based satellite mission designed to unify and advance precipitation measurements from a constellation of research and operational microwave sensors in order to improve our understanding of the Earth's water and energy cycles (Hou et al. 2014). GPM looks to build upon the success of the Tropical Rainfall Measuring Mission (TRMM) with improved technology, expanded global coverage, and more frequent temporal sampling. The technological improvements include a dual-frequency precipitation radar (DPR) that adds a Ka-band radar with increased sensitivity to light precipitation and the addition of high-frequency channels to the GPM microwave imager (GMI) for increased sensitivity to snowfall. Ensuring consistency among the sensors requires that the observed brightness temperatures (Tb) are consistent with expected differences

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Table 1: Channel complements for the GPM radiometer constellation. GPM GMI is the calibration reference sensor for the constellation. *TRMM TMI was turned off 8 April 2015 and the TRMM spacecraft re-entered the atmosphere on 15 June 2015 after operating for over 17 years. **Coriolis WindSat is used for calibration purposes, but is not currently part of the operational GPM radiometer constellation.

Satellite(Sensor)	6-7 GHz	10 GHz	18-19 GHz	21-23 GHz	31-37 GHz	85-92 GHz	150-166 GHz	183 GHz
GPM (GMI) Conical		10.65v 10.65h	18.7v 18.7h	23.8v	36.64v 36.64h	89.0v 89.0h	166 v/h	183.31±3v 183.31±7v
*TRMM (TMI) Conical		10.65v 10.65h	19.35v 19.35h	21.3v	37.0v 37.0h	85.5v 85.5h		
GCOM-W1 (AMSR-2) Conical	6.925v 6.925h 7.3v 7.3h	10.65v 10.65h	18.7v 18.7h	23.8v 23.8h	36.5v 36.5h	89.0v (A) 89.0h (A) 89.0v (B) 89.0h (B)		
DMSP F16, F17, F18,F19 (SSMIS) Conical			19.35v 19.35h	22.235 v	37.0 v/h	91.655v/h	150h	183.31±1h 183.31±3h 183.31±6.6h
METOP-A/B, NOAA-18/19 (MHS) Cross-track						89qv	157qv	183.31±1qh 183.31±3qh 190.31qv
Suomi NPP (ATMS) Cross-track				23.8qv	31.4qv	88.2 qv	165.5qh	183.31±1.0qh 183.31±1.8qh 183.31±3.0qh 183.31±4.5qh 183.31±7.0qh
Megha-Tropiques (SAPHIR) Cross-track								183.31±0.2qh 183.31±1.1qh 183.31±2.8qh 183.31±4.2qh 183.31±6.8qh 183.31±11qh
**Coriolis (WindSat) Conical	6.8v 6.8h	10.7v 10.7h 10.7-3rd 10.7-4th	18.7v 18.7h 18.7-3rd 18.7-4th	23.8v 23.8h	37.0v 37.0h 37.0-3rd 37.0-4th			

after accounting for variations in the observing frequencies, channel bandwidths, view angles, etc. It is the responsibility of the Inter-Satellite Calibration Working Group, or XCAL team, to produce the inter-calibrated level 1C Tb files that are used as input for the radiometer retrieval algorithm.

Table 1 provides the channel specifications for each of the GPM constellation radiometers, which consists of both conical-scanning imagers and cross-track scanning sounders. The coverage provided by the imagers and sounders in the constellation are shown in Figures 1a and 1b for January 1, 2015. While GMI provides the high quality observations critical for the *a priori* database used in the precipitation retrieval algorithm as well as the calibration reference, the other constellation members provide most of the sampling coverage. Significant differences in channel availability between sensors lead to challenges in ensuring consistent sensor calibration as well as the precipitation retrieval algorithm. The GMI instrument on board the GPM Core satellite is used as the calibration reference as it is well calibrated and stable, in a non-sun-synchronous orbit, and can be used as a reference for both the conical and cross-track microwave radiometers. Design requirements for GMI were driven both by requirements for its use in building the a priori database for the microwave precipitation retrieval algorithm as well as providing the reference calibration standard for the GPM radiometer constellation (Hou et al., 2014) These included a shroud over the warm load to eliminate solar intrusions, a robust reflective antenna coating to minimize emissivity issues, and the addition of noise diodes for a four point calibration of the window channels (Draper et al. 2013). Post launch, a series of spacecraft attitude maneuvers were performed to check for potential calibration issues but were also used to develop corrections for magnetic-induced anomalies and to update the pre-launch derived spillover corrections. Subsequent analysis based on radiative transfer

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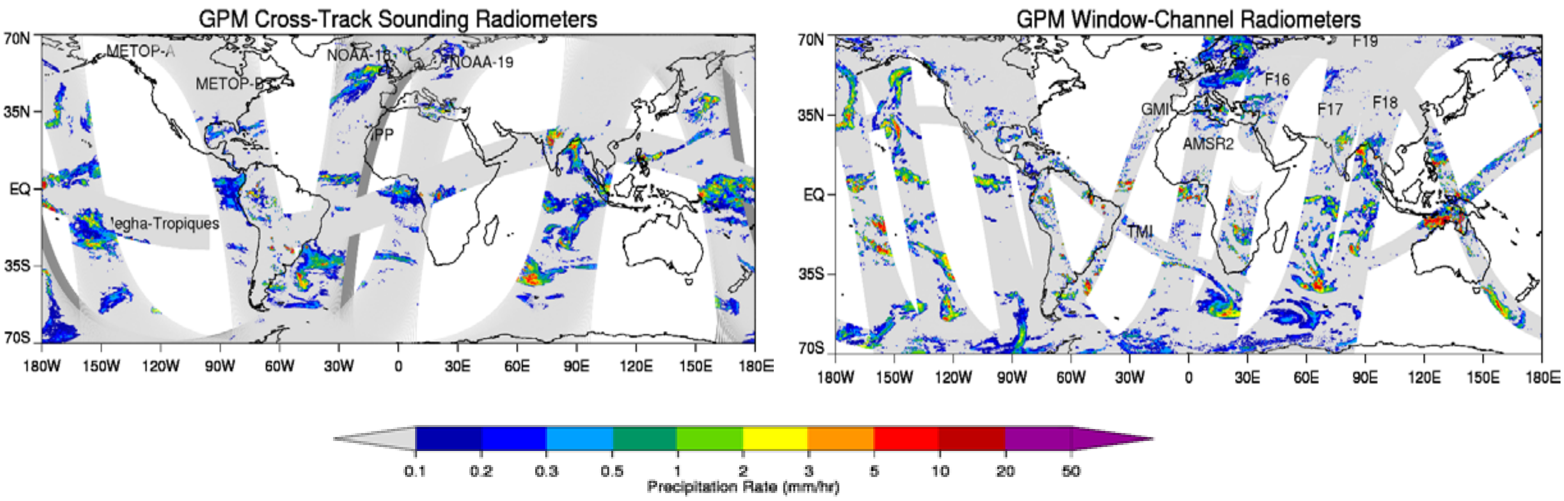

Figure 1: Coverage provide by a single orbital cycle from the GPM microwave constellation for January 1, 2015 for a) window-channel radiometers and b) cross-track sounding radiometers.

simulations and comparisons with other well calibrated sensors including WindSat and MHS suggest residual calibration errors less than 1K for all channels.

Methodology

The XCAL team approach to sensor inter-calibration involves several steps. The first step involves a pre-screening process in which calibration biases across the scan or along the orbit path are removed (Wilheit et al. 2013). Examples of these types of corrections include removing cross-track biases, accounting for an emissive reflector, and solar intrusions and/or thermal gradients in the hot load. Once corrections are applied, a variety of techniques developed by teams within XCAL are used to compare the calibrations of the constellation radiometers to the calibration reference sensor. To do this, channels at similar frequencies are compared, accounting for expected differences in viewing parameters, frequency, polarization, and view angles using radiative transfer models. For the imagers, calibration comparisons are performed over both radiometrically cold ocean scenes and highly vegetated warm land scenes such as the Amazon basin. Estimates from individual teams are based on different approaches and/or implementations (Wilheit et al. 2015), but they all use radiative transfer models along with geophysical parameters based on reanalysis or retrieval methods to compute the simulated i.e. expected Tb differences. Comparing results from multiple independent approaches helps to identify flaws or limitations of a given approach, increases confidence in the results, and provides a measure of the uncertainty in the resulting calibration offsets.

Inter-calibration versus GMI

Inter-calibration comparisons of the GPM constellation sensors with GMI indicate typical calibration differences within 2-3K for the window channels below 92 GHz. Larger differences were found for AMSR2, however, with the 18v and 36h channels more than 4K warmer than GMI. Figure 2 shows results for the AMSR2 18 GHz v-pol channel. AMSR2 is considerably warmer than GMI for cold scenes, but there is also a large temperature-dependence in the resulting calibration difference. SSMIS calibration differences were also found to vary with scene temperature, although to a much lesser degree. For the SSMIS channels above 150 GHz the differences are generally within ~2K with the exception of F19 which ranges from 7 to 11K colder than GMI depending on frequency. Finally, the calibration of the cross-track radiometers agrees very well with GMI with values mostly within 0.5K for SAPHIR and all four MHS sensors. Differences between GMI and ATMS on board NPP are slightly larger, but still remain within 1K for all channels.

Conclusion

The primary tasks of the XCAL team include verifying and correcting for identifiable calibration issues impacting the GPM constellation sensors and then adjusting for residual calibration inconsistencies to produce physically-consistent input Tb for the precipitation retrieval algorithm. GMI is used as the calibration standard for the constellation, verified using post-launch calibration maneuvers and subsequent analysis. Comparisons of GMI with the cross-track sounding sensors yield calibration differences within 1K for all channels, while with the exception of AMSR2, differences for the imager channels below 92 GHz tend to be within 2-3K. Analysis of data from post-launch calibration maneuvers for GMI show significant uncertainties in the pre-launch measured values, which may account for a significant part of the calibration differences with the other microwave imagers. The major tasks for the XCAL team going forward include understanding and quantifying the residual uncertainties in the estimated calibration differences due to the radiative transfer models and geophysical parameter retrievals, adapting to changes in the radiometer constellation, and revisiting previous radiometers to develop a long-term intercalibrated TRMM/GPM constellation data record.

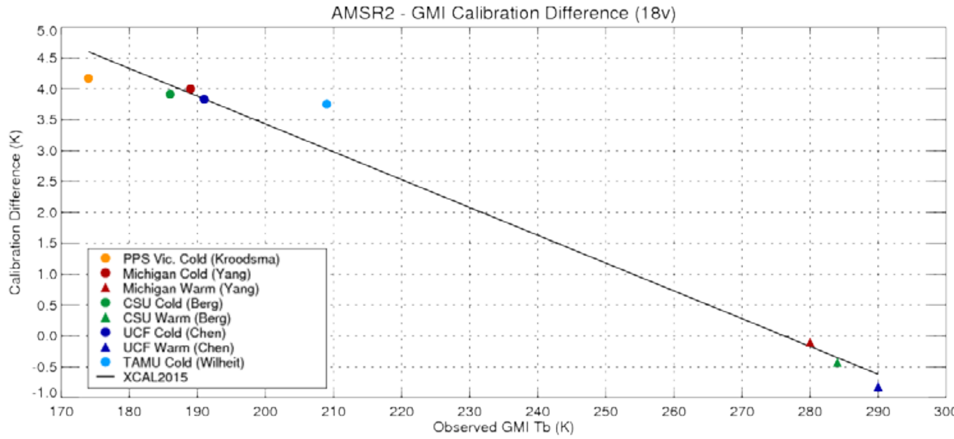

Figure 2: Intercalibration results for GCOM-W1 AMSR2 versus GPM GMI for the 18.7 GHz vertically-polarized channel. Independent results from each of the contributing groups are shown for radiometrically cold scenes (non-precipitating oceans) and warm scenes (vegetated non-polarized land). The final composite XCAL calibration adjustment for AMSR2 is shown by the solid black line.

References

Draper, D. W., et al., 2013, Global Precipitation Measurement Microwave Imager (GMI) hot load calibration, IEEE Trans. Geosci. Rem. Sens., Vol. 51, No. 9, 4731-4742, 10.1109/TGRS.2013.2239300.

Draper, D. W., et al., 2015, The Global Precipitation Measurement (GPM) Microwave Imager (GMI): Instrument Overview and Early On-orbit Performance, IEEE J. Sel. Topics Geosci. Remote Sens., Vol. 8, No. 7, 3452-3462, 10.1109/JSTARS.2015.2403303.

Hou, A. Y., Kakar, R. K., Neeck, S. A. Azarbarzin, A., Kummerow, C. D., Kojima, M., Oki, R. Nakamura, K. and Iguchi, T., 2014, The Global Precipitation Measurement Mission, Bull. Amer. Meteor. Soc., Vol. 95, 701-722, 10.1175/BAMS-D-13-00164.1.

Wilheit, T., 2013, Comparing calibrations of similar conically-scanning window-channel microwave radiometers, IEEE Trans. Geosci. Rem. Sens., Vol. 51, No. 3, 1453-1464, 10.1109/TGRS.2012.2207122.

Wilheit, T., Berg, W., Ebrahami, H., Kroodsma, R., McKague, D., Payne, V. and Wang, J., 2015, Intercalibrating the GPM constellation using the GPM microwave imager (GMI), Geoscience and Remote Sensing Symposium (IGARSS), 2015 IEEE International, 10.1109/IGARSS.2015.7326996.

Discuss the Article

Ground-based Automatic Observing Systems for CAL/VAL at Dunhuang, China Radiometric Calibration Site

By Yong Zhang (NSMC), Xin Li (CAS), Zhiguo Rong, Xiuqing Hu (NSMC) and Xiutian Ba (DMB)

Introduction

The China Radiometric Calibration Sites (CRCS) Dunhuang site (40.1821°N, 94.3244°E) is located in the Gobi Desert in northwest China, about 35 km west of Dunhuang City, Gansu Province. Covering approximately 30 km × 30 km, the entire site is formed on a stable alluvial fan of the Danghe River and its surface consists of cemented gravel without vegetation [1]. This site was chosen as a CRCS site due to its extremely homogeneous surface conditions. The detailed characteristics of the CRCS Dunhuang Site are listed in Table 1. According to the climatic conditions, this site can be used all year. The center area (600 m × 600 m) of the site is designed for high spatial resolution visible/near-infrared (VIS/NIR) sensors such as the China-Brazil Earth Resources Satellite (CBERS) series [2]. The extended large area (20 km × 20 km) is used for low spatial resolution sensors such as the Multichannel Visible and Infrared Scanning Radiometer (MVISR),

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Visible and Infrared Radiometer (VIRR) and Medium Resolution Spectral Imager (MERSI) onboard the Fengyun-1 and 3 (FY-1/3) series of polar-orbiting satellites. It is also used for the field calibration of the VIS/NIR channels on Chinese geostationary weather satellites (FY-2 series). The field calibration for the FY series of satellites has been conducted operationally since 2001 for only the VIS/NIR channels. Due to the lack of onboard VIS/NIR calibrators, the in-orbit calibration based on the CRCS Dunhuang site is still the primary method for China's satellite sensors' VIS/NIR channels, such as the FY series of satellites, the Haiyang (HY) series of Ocean Satellites, the Disaster and Environmental Monitoring Satellites (HJ) and the CBERS series satellites [1,3]. In recent years, the CRCS Dunhuang site has also been used for FY satellite IR channel field radiometric calibration.

Ground-based Automatic Observing Systems for CAL/VAL at Dunhuang

1. Field observing station

In order to improve the observing data quality and the automatic observing ability, a new field observing station was built at CRCS Dunhuang site. The field observing station is composed of a house, observing field, instrument platforms, power supply, tower crane, road to the station and safety facilities. There are five functional divisions designed into the house: electrical distribution facilities, instruments storage area, central control area, instruments on site calibration lab and rest area. The house is 3.5 meters height, 25 meters long and 8 meters wide, totally 200 m^2 with a walkable hard roof.

Table1. Detailed characteristics of CRCS Dunhuang Site

Feature Parameters		CRCS Dunhuang Site
Location		Dunhuang City, Gansu Province 40.1821°N, 94.3244°E
Altitude		1160m
Area		30km×30km
Surface feature		Gobi desert without vegetation
Climate type		Dry continental climate
Averaged annual meteorological parameters	surface pressure	887.6hPa
	surface air temperature	9.5℃
	Annual precipitation	34.1mm
	Surface relative humidity	43.9%
	Annual sunshine time	3270 hours
	Annual clear days	112.2 days
	Days of visibility larger than 10km	288.2 days
Reflectivity in VIS/NIR channels		15 – 30 %

2. Observing field

Figure 1 showed the design of the observing field. The field observation scheme is shown in Figure 2. In the 1 km × 1 km scale according to the FengYun series satellites spatial resolution, there are four observing units include the field observing station (rectangle in Figure 2). In the other three locations (circles in Figure 2), some essential instruments are deployed and automatic observing is conducted.

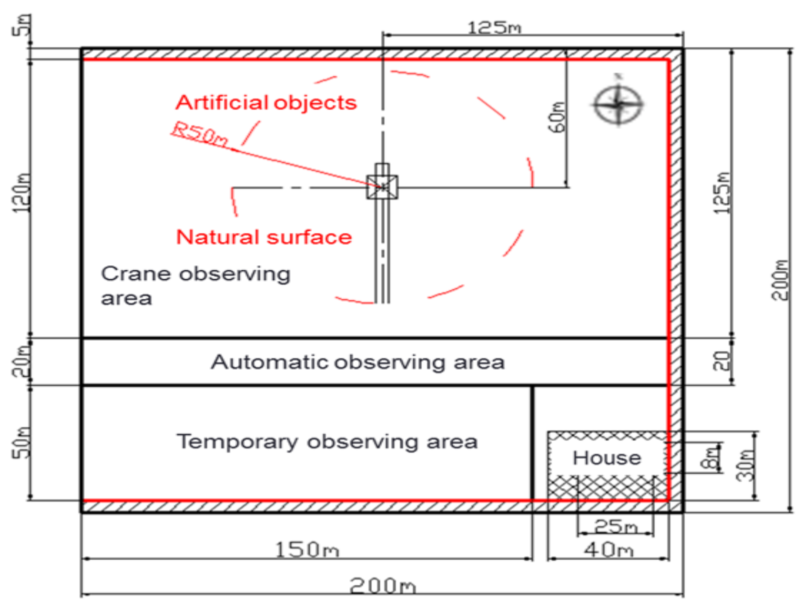

Figure 1: Design of the observing field

3. Tower crane

A tower crane was set up in the field observing station (shown in Figure 3). The crane is 30 m tall and the jib is 50 m long. The instrument nacelle can be moved to different height and spatial locations. The earth observation instruments in the nacelle can view the Gobi surface with different elevations, viewing angles and locations. The tower

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of the crane can be used as a pole to deploy the automatic meteorological station at different heights to collect the profiles of the atmospheric parameters in the ground layer.

Discussions and future work

Basic constructions of the observing station were completed in August 2015. The field observing station will be an open field test and exchange platform for sharing of test data, research and infrastructure, promote exchange and cooperation between the relevant disciplines and units. Some automatic observing instruments have been deployed at CRCS Dunhuang site, such as Automated test-site radiometer (ATR), Self-calibration spectra-radiometer (SCSR), High-precision solar radiometer (HSR), Solar spectra-radiometer (SSR), VIS-SWIR spectra-radiometer (VSSR), Sun-tracking photometer (CE318) and others[4].

In the future, the operational observations of different instruments, not only the ground surface observing but also the atmospheric and solar observing ones, all need to maintain automatic working modes. This should be combined with more attention to the data analysis and processing components.

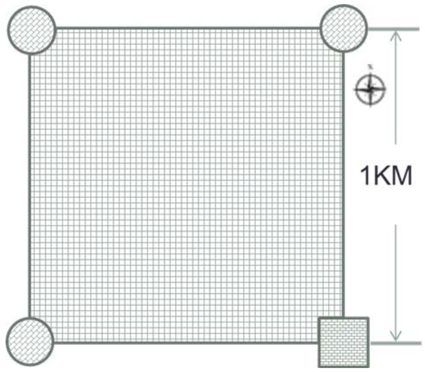

Figure 2: Observing Scheme

Figure 3: Photograph of the tower crane

Acknowledgement

The authors would like to acknowledge, with thanks, the contribution from their colleagues who worked on the China radiometric calibration sites in National Satellite Meteorological Center, China Meteorological Administration. This work was supported by the Natural Science Foundation of China under Grants 40701118 and 41171275 and in part by the R&D Special Fund for Public Welfare Industry under Grant GYHY200906036.

References

[1] Zhang, Y., Z. Li, and J. Li, Comparisons of emissivity observations from satellites and the ground at the CRCS Dunhuang Gobi site, J. Geophys. Res. Atmos., 119, doi:10.1002/2014JD022216. (2014).

[2] Zhang, Y., X. Gu, T. Yu, Y. Zhang, L. Cheng, X. Y. Li, X. Li, and L. He, "Absolute radiometric calibration of CBERS-02 IRMSS thermal band", Science in China Ser. E Engineering and Materials Science, 48(Supp.I) : 72-90 (2005).

[3] Hu, X., J. Liu, L. Sun, Z. Rong, Y. Li, Y. Zhang, Z. Zhao, R. Wu, L. Zhang, and X. Gu, Characterization of CRCS Dunhuang test site and vicarious calibration utilization for Fengyun (FY) series sensors, Canadian Journal of Remote Sensing, 36(5): 566-582 (2010).

[4] Zhang, Y., X. Li, Z. Rong, L. Zhang, X. Hu and X. Ba, China Radiometric Calibration Sites Ground-based Automatic Observing Systems for CAL/VAL, SPIE 9639-50. (2015).

Discuss the Article

News in this Quarter

GSICS Microwave subgroup updates

By Ralph Ferraro, Chair GSICS Microwave Subgroup, NOAA

During 2015, the Microwave Subgroup (MWSG), which is a component of the GSICS Research Working Group (GRWG), met three times through WebEx (January 13, May 13 and September 16) and also participated at the GSICS User's Workshop (both remotely and in person). The MWSG also held their 2016 kick-off meeting on January 6, 2016. This article provides a short summary of some of the topics discussed at the meetings, progress being made towards defining GSICS MW product and goals for the upcoming year.

Membership

The MSWG consists of approximately 25 members from nine organizations (and their affiliates), which includes

NOAA, NASA, NIST, EUMETSAT, JAXA, JMA, CMA, KMA, and IISC. It is a "well rounded" group of researchers that includes satellite sensor engineers, calibration specialists, algorithm developers and users of the products (including real-time and climate applications). Expanding the membership to include such a diverse group is a continuing goal of the MWSG; during the past year new institutes, e.g., IISC (India) and ISAC-CNR (Italy), joined the group.

Scope of the MWSG

The MWSG looks to develop and make available to GSICS Users radiometric corrections to passive MW sensors that could be used for real-time use (i.e., forward looking measurements of NWP model assimilation and weather forecasting applications) and retrospective use (i.e., climate products). One of the GSICS principles is that the calibrations should be made to a "reference", preferably an in-orbit reference (Level 1b). Since no true MW reference exists, a current challenge is for the MWSG to define proxy references or methodologies that are acceptable to GSICS. More is explained later in this article. Ultimately, the MWSG would like to develop a "set of corrections" that would be updated on a regular basis that would constitute a "product", along with the correction methodology.

Scientific Progress

In 2015, three MWSG Web meetings were held. During each meeting, at least two scientific updates are provided by members of the MWSG. Topics include status of Climate Data Records (CDR) derived from passive MW sensors, sensor calibration activities from both long term records (e.g., MSU/AMSU, SSM/I and SSMIS, etc.) and newer instruments (e.g., AMSR-2, GMI, SAPHIR, etc.) and the development of reference standards. The chair of the MWSG then solicited input from the group for potential speakers at upcoming meeting to ensure that scientific progress is reported on from as many members as possible.

In the past year, we have seen much progress on these topics, including the maturation of CDR's, improved calibration of the AMSR-2 sensor, tremendous progress on cross-calibration with the GPM GMI, as well as exploitation of the SAPHIR to compare with the ATMS sensor. At the first web meeting on 2015-01-13 (see https://gsics.nesdis.noaa.gov/wiki/Development/20150113), the primary science topics focused on the status of the calibration of the AMSR-2 (Keiji Imaoka), GMI (Rachael Kroodsma) and the SCOPE-CM Microwave project (Karsten Fennig). Data from the SCOPE-CM project include SSM/I, SSMIS and SMMR. Details can be found at https://wui.cmsaf.eu/safira/action/viewDoiDetails?acronym=FCDR_SSMI_V001.

The second web-meeting was held on 2015-05-13 (see https://gsics.nesdis.noaa.gov/wiki/Development/20150513) and focused on two main science issues. The first was discussion led by Manik Bali to develop some potential Metadata and file naming conventions for future GSICS microwave products. Rachel Kroodsma provided an update on the ongoing activities of the GPM X-Cal group.

The following MSWG meeting on 2015-09-16 (see https://gsics.nesdis.noaa.gov/wiki/Development/20150916) had presentations on a comparison study between ATMS and SAPHIR (Isaac Moradi) as well as the outcomes of the Joint Workshop on Uncertainties at 183 GHz (Paris, France, June 29-30, 2015) as described by Vinia Mattioli.

The most recent MSWG meeting on 2016-01-06 (see https://gsics.nesdis.noaa.gov/wiki/Development/20160106) focused on evaluating the responses from the GSICS User's Workshop and a potential path forward in 2016 by the MSWG. This discussion was led by Manik Bali, Tim Hewison and Ralph Ferraro. Additionally, David Walker of NIST has made great strides in the development of ground-based microwave references that will be used to calibrate future ATMS sensors to be flown on NOAA's JPSS satellites. For the primary standard target NIST has achieved a significant reduction in target uncertainty (~ 0.1 K) which is summarized in Figure 1.

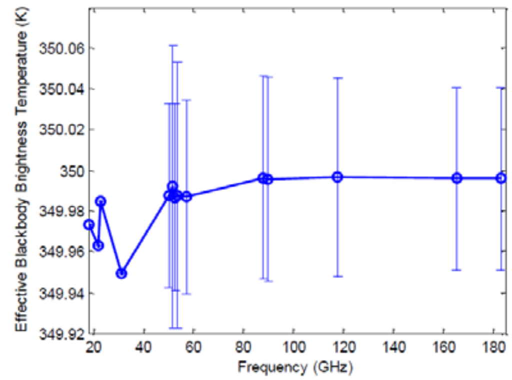

Figure 1: Estimated black body temperature uncertainty for ATMS.

Linkages with Other Calibration Groups

Satellite calibration is not only the focus of GSICS, but also other international programs. The MWSG includes members that participate in a number of these programs – NOAA's CDR and WMO's SCOPE-CM; NASA's GPM X-Cal group and the CEOS MW group. Part of the science updates includes reports from these members who are performing relevant work that benefit multiple programs (but that have slightly different emphasis). Reports have given new insight to our understanding of the in-orbit state of GMI (see article by Berg and Kroodsma) which can act as an in-orbit reference. From CEOS Xiolong Dong is leading the MW activities and Cheng-Zhi Zou has a tentative plan to leverage the IGARSS 2016 meeting (Beijing, July 2016) to have these two groups meet (See announcement on Page.17 of this issue)

GSICS MW Products – What do the users want?

At the 2015 GSICS User's Workshop – a one-day meeting held in conjunction with the EUMETSAT Annual Satellite Conference in November 2015 (Toulouse, France) – responses to a user survey were presented. A short summary of the responses indicated that most users were primarily interested in level 1 radiance corrections for both operational and research sensors; inter-satellite corrected radiances from a sensor type; routine, but not necessarily frequent updates to these corrections;

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use such corrections for global trend monitoring and the derivation of geophysical parameters.

Plans for Upcoming Year

For the upcoming year, the MWSG plans on developing a clear path for GSICS MW products and services, namely, defining initial correction tables for some of the longer time series (e.g., MSU, AMSU, SSM/I) that can be used for real-time and climate applications, defining reference standards (i.e., satellite, radiative transfer model, etc.) and common services (i.e., common cross calibration methods like SNO) that GSICS agencies could adopt when performing calibration of their individual sensors. The MWSG will also continue to mature relationships with other groups such as the GPM X-Cal (see article by Berg and Kroodsma in this issue) and the CEOS MW group.

Details on the MWSG meetings can be found on the GSICS Wiki Page - https://gsics.nesdis.noaa.gov/wiki/Development/MeetingsAndConferences.

Discuss the Article

Joint Workshop on uncertainties at 183 GHz held in Paris, France

By Vinia Mattioli, EUMETSAT

The Joint workshop on uncertainties at 183 GHz was held in Paris, France, on June 29-30, organized by Hélène Brogniez of LATMOS, Stephen English of ECMWF, and Jean-François Mahfouf of Météo-France. Its focus was the discussion of biases observed between brightness temperature (TB) measurements and calculations at 183 GHz. Specifically, cross-comparisons between existing sounders showed a very good consistency among them, within the instruments' radiometric noise (Moradi et al, 2015). However, when those measurements were assimilated in a NWP model, or compared against radiative transfer model calculations using radiosonde profiles, a channel-dependent bias increasing from the centre to the wings of the 183 GHz line was observed (Figure 1). As such, the workshop aimed at identifying possible explanations for such biases.

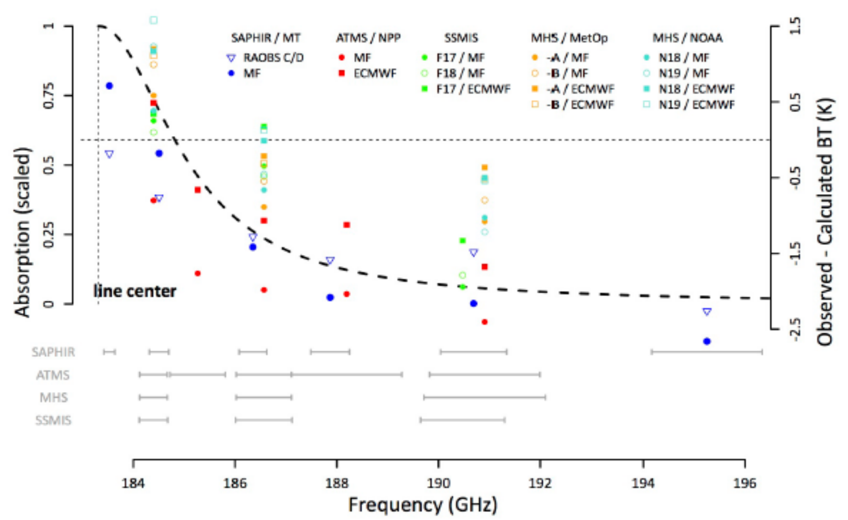

Figure 1: Observed minus calculated BT using either radiosondes measurements (RAOBS from the CINDY/DYNAMO/AMIE field campaign, winter 2011-2012, triangles) or NWP models of Meteo-France (MF, circles) or of European Center for Medium-range Weather Forecasts (ECMWF, squared). Each colour refers to a specific sensor, specified in the legend. All the calculated BTs have been done using the RTTOV model.

The workshop was formatted around overview sessions with stimulating introductory presentations followed by working group (WG) sessions that triggered intense and valuable discussions. WG1 was specific on biases in "in situ" observations, and tried to evaluate the absolute and relative accuracy of references as Radiosondes, Global Navigation [RSP/TJH2]System Satellite (GNSS) observations, and lidars.WG2 focused on space-borne observations, trying to assess accuracy in the absolute calibration of instruments at 183 GHz and to understand limits and uncertainties associated to satellite sensor inter-comparison. WG3 was devoted to spectroscopy and radiative transfer, and finally, WG4 was related to identifying possible biases arising from analysis techniques.

WG1 and the overview session discussed radiosondes' merits and limits. Radiosondes are subject to errors arising from several sources: calibration, time-lags, solar radiation heating. Nevertheless, errors in lower troposphere relative humidity profiles are around 2-5%, small enough not to have an impact at 183 GHz. Errors in upper tropospheric humidity are larger, although these would affect comparisons near the line centre (Clain et al., 2015; Mattioli et al., 2008).

GNSS estimations of the atmospheric precipitable water vapour have a mean uncertainty of about 2% (Ning et al., 2015), while lidar accuracy (Raman system and DIAL) is less than 5% (Wulfmeyer et al. 2015). It was discussed that spatial and temporal mismatches between the satellite measurements and the ground stations may introduce systematic biases in the observed-calculated TB difference.

In Session 2, the calibration status of the 183 GHz channels of various sensors was discussed. Comparisons of observations from GMI with four operational MHS sensors as well as ATMS and SAPHIR instruments have been performed by the Global Precipitation Mission (GPM) inter-calibration working group (XCAL team), using a double difference technique. The differences show very consistent results, with double differences within 1K for all channels with no temporal trend. The importance of homogenisation procedures for comparing microwave humidity sounders was also addressed. WG2 highlighted the value of post-launch calibration satellite manoeuvres, as performed for GMI. It was also strongly encouraged to record digital data and metadata of spectral response functions and antenna patterns for future instruments. Attention was also posed on the correct methodology for handling sideband asymmetry and for combining pass bands in double-side bands, as well as for the conversion from radiance to TB, which should be done consistently or could create systematic differences

In WG3, it was shown that in the inter-comparison among radiative transfer (RT) models, including reference and fast models, TB differences are mainly attributed to the differences in spectroscopy and continua and not to the RT models themselves (Garand et al., 2001; Buehler et al., 2006; Hewison, 2006), except for extreme atmospheric situations. To evaluate the impact of spectroscopy uncertainties, sensitivity tests have been performed using the Monochromatic Radiative Transfer Model (MonoRTM) (Payne et al., 2011; Clough et al., 2005). It was shown that estimated uncertainties on the foreign- (±3%) and self-broadened (±15%) half widths (Payne et al., 2008) are too small to explain the observed bias. In addition, the spectral shape associated with an error in the line width is not consistent with the spectral shape of the observed bias. Also, assumed uncertainties on the temperature exponent (15%) and the pressure shift (20%) cannot be used to explain the observed bias. Uncertainty in the continua is still debated. Ground-based measurements place strong constraints and showed discrepancies that are not yet understood with respect to the continuum coefficients obtained from known laboratory measurements. The ozone line has a small impact (0.2-0.3K) around 184 GHz. Finally, recently laboratory studies have resulted in unambiguous detection of water vapour dimer absorption in the millimetre-wave range (Tretyakov et al., 2013), which is not accounted for in the current version of widely-used continuum models. Results presented in Odintsova et al. (2014) indicate that the inclusion of dimer absorption can produce small-scale spectral variation of 0.5 to 1 K in up-looking millimetre-wave spectra and its broader impact in the RT modelling of the 183-GHz channels has yet to be determined.

As discussed in WG4, radiosonde observations are anchor measurements in the assimilation systems. It is then possible that humidity analyses share similar bias characteristics with radiosondes, which might explain some of the consistency between the spectral gradient-dependent bias found against both in situ measurements and NWP simulations. Cloud detection is an issue that affects most comparisons – because of the intrinsic difficulty in the cloud screening, residual biases may be present. Alan Geer reported a comparison of first guess departures at ECMWF using clear-sky and cloudy assimilation schemes, which suggested residual cloud contributed about 0.4 K at 183±3 GHz and 183±7 GHz.

To summarize the findings of the workshop, it appears that the overall bias is a combination of multiple error sources. Several recommendations were envisaged, which included improving the quantification of the effect of undetected clouds; reinforcing the links between instrument designers, calibration experts and spectroscopy experts, testing the impact of new spectroscopic data sets, encouraging cross comparisons of water vapour measurements by lidar, radiosondes and models. The workshop reflected the aims of GSICS to provide a full uncertainty analysis of comparisons to understand the various components of the observed biases. The report of the workshop with full details of references is available to download at: http://meghatropiques.ipsl.polytechnique.fr/available-documents/meeting-workshop/index.html.

Discuss the Article

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Jason-3 and Sentinel-3A launched

By Manik Bali, NOAA

Last quarter saw the launches of two important Earth observation satellites, Jason-3 on 17 January 2016 launched by Space-X, and Sentinel-3A on 16 February 2016 and launched aboard a Vega Rocket.

Jason-3 is a successor of Jason 1, Jason 2 and the Topex/POSEIDON missions. It is a joint mission between US and the European Union with operational agencies NOAA, EUMETSAT and CNES. The main aim of Jason-3 is to make detailed measurements of the sea-level height to gain insight into ocean circulation and climate change. It has four instruments onboard. These are Altimeter, Microwave Radiometer, Laser Retroreflector Array (LRA) and a Global Positioning System to measure the height of the ocean surface. While the Jason-3 mission will continue the core satellite altimetry measurements for physical oceanography - the plans call in addition for the transition from research to operational applications of this valuable measurement.

Sentinel-3A is a European Space Agency mission that is aimed to measure sea-surface topography, sea- and land-surface temperature and ocean- and land-surface color with accuracy in support of ocean forecasting systems, and for environmental and climate monitoring.
It has the following instruments on board:

1. SLSTR (Sea and Land Surface Temperature Radiometer) will determine global sea-surface temperatures to an accuracy of better than 0.3 K . It measures in nine spectral channels and two additional bands optimised for fire monitoring. It is expected to provide continuity to the A/ATSR series of instruments.
2. OLCI (Ocean and Land Colour Instrument) is a medium-resolution imaging spectrometer that uses five cameras to provide a wide field of view. SLSTR and OLCI are optical instruments with an overlap of their swath path, allowing for new combined applications.
3. SRAL (SAR Altimeter) is the main topographic instrument to provide accurate topography measurements over sea ice, ice sheets, rivers and lakes. It uses dual-frequency Ku and C band and is supported by a microwave radiometer for atmospheric correction and a DORIS receiver for orbit positioning.
4. DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) is a receiver for orbital positioning.
5. MWR (Microwave Radiometer) will measure water vapor and cloud water content and the thermal radiation emitted by the Earth.
6. LRR (Laser Retroreflector) will be used to accurately locate the satellite in orbit using a laser ranging system. When used in combination with SRAL, DORIS, MWR, they will acquire detailed topographic measurements of the ocean and in-land water.
7. GNSS (Global Navigation Satellite System) will provide precise orbit determination and can track multiple satellites simultaneously.

From a GSICS standpoint the SLSTR and OLCI would be of special interest. SLSTR has a robust onboard calibration mechanism. This mechanism uses two SI traceable blackbodies heated to each end of the SST temperature range, as reference targets. This pins down the detector nonlinearity in the SST range and can result in a very high quality of measurements in the SST temperature range. In GSICS, the SLSTR can act as a tool to monitor GSICS references such as IASI and CrIS. OLCI has very demanding requirements for the calibration of visible channels and can be used to test GSICS inter-calibration algorithms.

Discuss the Article

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Announcements

2016 EUMETSAT conference to be held in Darmstadt

By Gabriele Kerrmann, EUMETSAT

The 2016 EUMETSAT Meteorological Satellite Conference will take place from 26 to 30 September 2016 in Darmstadt Germany The Call for Papers is available on the EUMETSAT website at http://bit.ly/EMSC2016.

The conference will cover the following topics

1. Current and future satellite programmes and instruments
2. Use of satellite data for nowcasting and short-range NWP
3. The Arctic challenge
4. Marine meteorology and oceanography
5. The role of satellite data records in climate services
6. Space based atmospheric composition measurements: forecasting air quality

Important dates are

REGISTRATION DEADLINES AND FEES

Registrations submitted by 26 June 2016: early registration fee of €280

Registrations submitted by 4 September 2016: standard registration fee of €330

Registrations submitted after 4 September 2016 and on-site: late registration fee of €400

The registration website will open in May 2016

Discuss the Article

25th CALCON meeting to be held in Logan,Utah, USA

By Changyong Cao, NOAA

The Characterization and Radiometric Calibration for Remote Sensing (CALCON) 25th annual meeting will be held 22-25 August 2016 at Utah State University in Logan, Utah USA. CALCON provides a forum for scientists, engineers, and managers to present, discuss, and learn about calibration, characterization, and radiometric issues within the microwave, IR, visible, and UV spectral ranges. GSICS members are encouraged to attend the conference. Technical sessions will be organized to cover a wide range of topics that address interests of the larger sensor calibration community, dependent on the number and quality of submissions received. Each session will focus on a broad theme represented in a selected group of submitted abstracts.

A detailed list of suggested topics are at http://www.calcon.sdl.usu.edu/technical-program/call. While most of themes are relevant to GSICS,the session on Pre-launch and Post-launch performance would be of particular interesting as it aims to address in-orbit instrument monitoring and prelaunch characterization. Abstracts are due April 5, 2016. For more details, please visit http://www.calcon.sdl.usu.edu/.

Discuss the Article

CEOS-GSICS Microwave Coordination Meeting to be held in Beijing, China July 4-5, 2016

Cheng Zhi- Zou, NOAA

This year a "CEOS-GSICS Microwave Coordination Meeting' will be held in Beijing, China during July 4-5, 2016. The main aim is to foster collaboration between CEOS Microwave Subgroup and the GSICS Microwave Subgroup. The former group has been mainly focusing on CAL/VAL and data quality assurance of microwave sensors and the later group on inter-calibration of microwave sensors. The main purpose of the meeting is to

- Identify currently available calibration/inter-calibration algorithms and products at the GSICS Microwave Subgroup
- Identify currently available calibration/inter-calibration algorithms and products at the CEOS Microwave Subgroup

- Exchange of microwave standard procedure/definitions at the GSICS and CEOS Microwave Subgroups
- Exchange of ideas and collaborations between the GSICS and CEOS Microwave Subgroups
- New instruments, products and future directions for the GSICS and CEOS Microwave Subgroups

We invite the microwave calibration, validation and data product quality assurance and inter-calibration experts within the CEOS and GSICS working groups as well as in the other microwave satellite community to participate in the meeting. The deadline for submitting abstract is May 15, 2016.

The contact for the meeting is:

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GSICS Product Ownership and Redistribution Principles

By GSICS Executive Panel

The 12th session of the GSICS Executive Panel (EP-12 Final Report) reached a decision on accessibility and acknowledgement of GSICS Products. The GSICS Executive Panel decision states:

"Information delivered as a GSICS product is generated in accordance with GSICS principles and practices. GSICS products are public and may be used and redistributed freely. Any publication using GSICS products should acknowledge both GSICS and the relevant data creator's organization. Neither the data creator, nor the data publisher, nor any of their employees or contractors, makes any warranty on the data express or implied, including warranties of merchantability and fitness for a particular purpose, or any assumed legal liability for the accuracy, completeness, or usefulness, of this information".

Discuss the Article

GSICS-Related Publications

Claverie, M., Vermote, E. F., Franch, B and J. G. Masek.,2015, Evaluation of the Landsat-5 tm and Landsat-7 ETM+ surface reflectance products. *Remote Sens. Environ.*, *169*, 390–403.

Datla, R., Shao, X., Cao, C and X. Wu, 2016, Comparison of the Calibration Algorithms and SI Traceability of MODIS, VIIRS, GOES, and GOES-R ABI Sensors. *Remote Sens.*, *8*, 126.

McCorkel, J., Cairns, B., and A. Wasilewski.,2016, Imager-to-radiometer in-flight cross calibration: RSP radiometric comparison with airborne and satellite sensors, Atmos. Meas. Tech., 9, 955-962, doi:10.5194/amt-9-955-2016.

Quan, W. (2015), A Multiplatform Approach Using MODIS Sensors to Cross-Calibrate the HJ-1A/CCD1 Sensors Over Aquatic Environments Journal Of The Indian Society Of Remote Sensing Vol. 43 No. 4 pp. 687-695.

Discuss the Article

Submitting Articles to GSICS Quarterly Newsletter:

The GSICS Quarterly Press Crew is looking for short articles (~800 to 900 words with one or two key, simple illustrations), especially related to calibration and validation capabilities and how they have been used to positively impact weather and climate products. Unsolicited articles are received for consideration anytime, and if accepted, will be published in the next available newsletter issue after approval/editing. Note the upcoming spring issue will be a general issue. Please send articles to manik.bali@noaa.gov.

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With help from our friends:

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